EORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL
[ ] REVISION NO. ____

roject No. A-2926 — DATE: 4/17/81

roject Director: Mr. T. A. McFadden — ~~School~~/Lab EML/RSD

ponsor: U. S. Army Missile Command; Redstone Arsenal, AL 35898

ype Agreement: Delivery Order No. 0013 under Contract No. DAAH01-81-D-A003

ward Period: From 3/30/81 To ~~6/30/81~~ 9/30/81 (Performance) 8/31/81 (Reports)

ponsor Amount: $31,000 — Contracted through:

ost Sharing: None — GTRI/~~GIT~~

itle: IHAWK Digital Avionics and Integrated Guidance Concept

ADMINISTRATIVE DATA — OCA CONTACT Duane Hutchison x 4820

1) Sponsor Technical Contact: Dr. M. M. Hallum; Systems Simulation and Development Directorate; U. S. Army Missile Command; Attn: DRSMI-RDF; Redstone Arsenal, AL 35898 205/ 876-4141

2) Sponsor Admin./Contractual Contact: Mr. Thomas A. Bryant; ONR Resident Representative; Georgia Institute of Technology; 206 O'Keefe Building; Atlanta, GA 30332.

Reports: See Deliverable Schedule — Security Classification: Unclassified

Defense Priority Rating: DO-A2 under DMS Reg. 1

RESTRICTIONS

See Attached DOD Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval - Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with Government; except that items costing less than $1,000 vests with GIT if prior approval to purchase is obtained from the Contracting Officer.

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Other: Mr. McFadden - Huntsville Ops.

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

# SPONSORED PROJECT TERMINATION SHEET

Date 12/29/81

Project Title: IHAWK Digital Avionics and Integrated Guidance Concept

Project No: A-2926

Project Director: Mr. T. A. McFadden

Sponsor: U. S. Army Missile Command; Redstone Arsenal, AL 35898

Effective Termination Date: 9/30/81

Clearance of Accounting Charges: 11/30/81 (Reporting)

Grant/Contract Closeout Actions Remaining:

- [X] Final Invoice and Closing Documents
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Assigned to: EML/RSD (School/Laboratory)

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FORM OCA 10:781

A-2926

# Monthly Technical Report No. 1
# and
# Monthly Cost and Performance Report No. 1

Report Period
March 30 to April 30, 1981

Report Prepared
May 18, 1981

T.A. McFADDEN

Contract No. DAAH01-81-D-A003
Project No. 2926

Prepared for

U. S. Army Missile Command
Attn: DRSMI-IYE/Smith
Redstone Arsenal, Alabama 35898

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

## WORK PERFORMED DURING THIS REPORTING PERIOD

During this reporting period the task of finding a suitable facility for the Radome Positioner and the Digital Avionic Unit has been undertaken. Such a facility has been located in an unused anechoic chamber in the A-Wing basement of building 5400. This facility may potentially allow the Digital Avionics Unit and the Radome Positioner to be used with the chamber on a time shared basis. A number of modifications will be made to the chamber to allow it to be used for both positioner and D.A. testing.

An opening has been cut into one side of the chamber, to provide an aperture for mounting the Radome Positioner. Also, lumber has been acquired and construction has begun on a platform which will be used to support the missile G. & C. section during Digital Avionics testing. This platform will also support personnel who will mount the Radome Positioner gimbal assembly.

To support missile testing in the A-Wing chamber, hydraulics must be provided. To accommodate this, an old Basic Hawk hydraulic set has been received from Letterkenny Arsenal in Pennsylvania. Preliminary investigations have begun to determine the feasibilty of using this pump in the A-Wing chamber.

The quality of the Anechoic material in the A-Wing chamber is unknown. In order to provide some measure of the quality of the microwave absorber material, two sections of this material have been removed from the chamber wall and have been shipped to The Rantek Corporation in California for analysis.

An equipment list has been generated and sent to Mickey Hallum. This equipment list identifies a number of critical items of test equipment which are necessary for any testing to begin in the A-Wing chamber.

## PROBLEMS

None

## WORK PLANNED

- Monitor Rantek Corporation results and make recommendation
- Continue construction of Platform
- Interface with GFE Avionics and Positioner
- Checkout and install Missile Hydraulics
- Construct Chamber Antenna Tower

A- 2926

Cost Information

The following charges have been incurred against the contract during period 30 March through 30 April, 1981

| | Expended | Encumbered |
|---|---|---|
| Personal Services (PS) | $ 2,017.43 | -0- |
| Materials and Supplies | -0- | 206.89 |
| Travel | 190.78 | -0- |
| Overhead (@ 73% of PS) | 1,472.72 | -0- |
| Retirement (@ 11.11% of PS) | 221.80 | -0- |
| TOTAL | $ 3,902.73 | 206.89 |

The breakdown of personal services is as follows:

| | Dollars | Approximate Man Hours |
|---|---|---|
| Principal Research Scientists/Engineers | $ 419.97 | 18.00 |
| Senior Research Scientists/Engineers | 1,576.46 | 82.00 |
| Research Scientists II/Engineers II | -0- | -0- |
| Research Scientists I/Engineers I | -0- | -0- |
| Technicians/Draftsmen | -0- | -0- |
| Students | 21.00 | 4 |
| Secretarial/Clerical/Other | | |
| TOTAL | $ 2,017.43 | 104.00 |

The current financial status of the contract is as follows:

| | Budget As Proposed | Expended | Free Balance | Encumbered |
|---|---|---|---|---|
| Personal Services (PS) | $ 12,498.98 | $ 2,017.43 | $ 10,481.55 | -0- |
| Materials and Supplies | 7,805.80 | -0- | 7,598.91 | 206.89 |
| Travel and Shipping | 350.00 | 190.78 | 159.22 | -0- |
| Computer | -0- | -0- | -0- | -0- |
| Overhead | 9,124.26 | 1,472.72 | 7,651.54 | -0- |
| Retirement | 1,220.96 | 221.80 | 999.16 | -0- |
| FUNDING | $ 31,000.00 | $ 3,902.73 | $ 26,890.38 | $ 206.89 |

Based on present full funding, the funding and equivalent man hours are sufficient to complete the task. Approximately 10% of the proposed task has been completed.

A-2926

# Monthly Technical Report No. 2
# and
# Monthly Cost and Performance Report No. 2

Report Period
May 1 to May 31, 1981

Report Prepared
June 3, 1981

## IHAWK Digital Avionics Integration Guidance Concept

T. A. McFADDEN

Contract No. DAAH01-81-D-A003
Delivery Order No. 0013
Project No. A-2926

Prepared for

U. S. Army Missile Command
Attn: DRSMI-IYE/Smith
Redstone Arsenal, Alabama 35898

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

## WORK PERFORMED DURING THIS REPORTING PERIOD

During this reporting period significant progress has been made in modifying the A-wing Anechoic Chamber for Radome Positioner and Digital Avionics use. The aperture opened in the exterior wall of the Chamber has been extended to the Chamber's interior wall. This required the removal of several blocks of Anechoic material from the inside of the Chamber.

Construction of the wooden platform begun last month has now been completed. This platform which can be completely disassembled after use can be used to support personnel mounting the Radome Positioner Gimbal assembly. In addition, this platform will support the missile for Digital Avionics testing.

Arrangements have been made to secure a pair of OMTS units for the Chamber. These units are portable units which provide IH missile hydraulics and RF generation. A trip will be made to Barstow next month to secure these units.

The Anechoic material which was sent to Rantek has been tested and the results have been reported. The Anechoic material exhibits 30 db of attenuation at X-band. This should be more than adequate for our purposes in the Chamber.

Construction has been completed on the Chamber antenna tower. This tower has been bolted to the rear wall of the Chamber facing the apertured wall. The tower will permit one or two antennas to be mounted in the Chamber in various configurations. A rotating arm has been built into the tower to permit the mounting of a pair of horns in the vertical, horizontal, or diagonal planes. This feature will be used by the Digital Avionics unit in performing responses with the seeker head.

A support beam has been built in Atlanta and will be shipped here for installation in the Chamber. This beam will be placed in the Chamber wall framing the aperture to provide support for the Radome Positioner Gimbal assembly.

Discussions have begun with Dennis Kozakoff in Atlanta regarding the feasibility of Georgia Tech building the required horn antennas for use in the Chamber. In addition, Dennis has provided support for getting the other required RF equipment on order.

Problems

None

Work Planned

- Receive and install I-Beam support assembly.
- Acquire and install OMTS units.
- Receive and install RF equipment.
- Monitor Georgia Tech horn antenna manufacture.
- Speak to M. Fahey regarding a Chamber test plan.

Cost Information

The following charges have been incurred against the contract during period May 1 through 31 May, 1981.

| | Expended | Encumbered |
|---|---|---|
| Personal Services (PS) | $ 1,434.75 | -0- |
| Materials and Supplies | 228.29 | 206.89 |
| Travel | 56.66 | -0- |
| Overhead (@ 73% of PS) | 1,047.37 | -0- |
| Retirement (@ 11.11% of PS) | 128.90 | -0- |
| TOTAL | $ 2,896.57 | $ 206.89 |

The breakdown of personal services is as follows:

| | Dollars | Approximate Man Hours |
|---|---|---|
| Principal Research Scientists/Engineers | $ 84.00 | 3.50 |
| Senior Research Scientists/Engineers | 544.84 | 28.25 |
| Research Scientists II/Engineers II | 511.64 | 33.30 |
| Research Scientists I/Engineers I | -0- | -0- |
| Technicians/Draftsmen | -0- | -0- |
| Students | 294.22 | 52.63 |
| Secretarial/Clerical/Other | -0- | -0- |
| TOTAL | $ 1,434.70 | 117.68 |

The current financial status of the contract is as follows:

| | Budget As Proposed | Expended | Free Balance | Encumbered |
|---|---|---|---|---|
| Personal Services (PS) | $ 12,498.98 | $ 3,452.18 | $ 9,046.80 | $ -0- |
| Materials and Supplies | 7,805.80 | 228.89 | 7,576.91 | 206.89 |
| Travel and Shipping | 350.00 | 247.44 | 102.56 | -0- |
| Computer | -0- | -0- | -0- | -0- |
| Overhead | 9,124.26 | 2,520.09 | 6,604.17 | -0- |
| Retirement | 1,220.96 | 350.70 | 870.26 | -0- |
| FUNDING | $ 31,000.00 | $ 6,799.30 | $ 24,200.70 | $ 206.89 |

Based on present full funding, the funding and equivalent man hours are sufficient to complete the task. Approximately 22% of the proposed task has been completed.

A-2926

# Monthly Technical Report No. 4 and 5
# and
# Monthly Cost and Performance Report No. 4 and 5

Report Period
June 1 through June 31, 1981

Report Prepared
July 28, 1981

## IHAWK Digital Avionics Integration Guidance Concept

T. A. McFADDEN

Contract No. DAAH01-81-D-A003
Delivery Order No. 0013
Project No. A-2926

Prepared for

U. S. Army Missile Command
Attn: DRSMI-IYE/Smith
Redstone Arsenal, Alabama 35898

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

## WORK PERFORMED DURING THIS REPORTING PERIOD

During this reporting period, a trip was made by T. A. McFadden and M. Thornton to the Barstow Marine Corp Depot. While at this facility, an inspection was made of all surplus Basic Hawk OMTS units warehoused there. After a visual inspection of the surplus units, two were selected for further testing in the radar repair shop on post. In the repair shop the RF signal levels and doppler shifts were checked. As a result of this examination two OMTS units were selected for shipment to Redstone Arsenal.

The aluminum support beams manufactured in Atlanta have been received and installed in the apertured wall of the A-wing chamber. These beams will provide support for the Radome Positioner Gimbal assembly.

Discussions have taken place with Dr. Fahey regarding a test plan for the chamber. Preliminary preparations have been made for performing these tests. In addition, some RF generation equipment has been received from the Advanced Sensors group for use in the chamber until permanent signal generating equipment is acquired.

The Radome Gimbal assembly has been installed in the wall of the chamber using the I-beam supports. Also a number of radomes have been moved to the chamber in preparation for testing.

### Problems

None

### Work Planned

- Receive and install the OMTS units
- Test the chamber
- Prepare for Radome testing

A-2926

Cost Information

The following charges have been incurred against the contract during period 1 June, through 30 June, 1981.

| | Expended | Encumbered |
|---|---|---|
| Personal Services (PS) | $ 8,785.57 | $ -0- |
| Materials and Supplies | 192.56 | 1,772.94 |
| Travel | -0- | -0- |
| Overhead (@ 73% of PS) | 6,413.47 | -0- |
| Retirement (@ 11.11% of PS) | 976.08 | -0- |
| TOTAL | $ 16,367.68 | $ 1,772.94 |

The breakdown of personal services is as follows:

| | Dollars | Approximate Man Hours |
|---|---|---|
| Principal Research Scientists/Engineers | $ -0- | -0- |
| Senior Research Scientists/Engineers | 2,913.51 | 116.0 |
| Research Scientists II/Engineers II | 2,692.82 | 134.0 |
| Research Scientists I/Engineers I | 1,840.39 | 115.0 |
| Technicians/Draftsmen | -0- | -0- |
| Students | 1,259.20 | 125.0 |
| Secretarial/Clerical/Other | 79.65 | 11.0 |
| TOTAL | $ 8,785.57 | 501.00 |

The current financial status of the contract is as follows:

| | Budget As Proposed | Expended | Free Balance | Encumbered |
|---|---|---|---|---|
| Personal Services (PS) | $ 12,498.98 | $ 12,237.75 | $ 261.23 | $ -0- |
| Materials and Supplies | 7,805.80 | 421.45 | 5,611.41 | 1,772.94 |
| Travel and Shipping | 350.00 | 247.44 | 102.56 | -0- |
| Computer | -0- | -0- | -0- | -0- |
| Overhead | 9,124.26 | 8,933.56 | 190.70 | -0- |
| Retirement | 1,220.96 | 1326.78 | -105.82 | -0- |
| FUNDING | $ 31,000.00 | $ 23,166.98 | $ 6,060.08 | $1,772.94 |

Based on present full funding, the funding and equivalent man hours are sufficient to complete the task. Approximately 75% of the proposed task has been completed.

A-2926

Monthly Technical Report No. 6
and
Monthly Cost and Performance Report No. 7

Report Period
July 1 through July 31, 1981

Report Prepared
August 26, 1981

# IHAWK Digital Avionics Integration Guidance Concept

T. A. McFADDEN

Contract No. DAAH01-81-D-A003
Delivery Order No. 0013
Project No. A-2926

Prepared for

U. S. Army Missile Command
Attn: DRSMI-IYE/Smith
Redstone Arsenal, Alabama 35898

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

## WORK PERFORMED DURING THIS REPORTING PERIOD

During this reporting period activity has slowed awaiting delivery of items such as the OMTS units, the new anechoic material, and an RF horn for use in the chamber.

In anticipation of delivery of the OMTS units from the Barstow Marine Corp Depot, the platform previously constructed to support personnel installing the Radome Gimbal assembly has been lengthened by five feet. This was necessary to allow the OMTS unit to be positioned under the platform without an overhang.

The power supply requirements of the OMTS unit have been examined. A work order to supply 400 cycle 3 phase power required by the OMTS unit submitted to Post Engineers in March, has been investigated. Due to an administrative error on the part of the Post Engineers scheduler, the 400 cycle power request was dropped from the work order. Consequently, a new work order has been initiated to acquire the necessary 400 cycle power.

Further chamber test discussions have taken place between John Dickens and Dr. Fahey. With this testing in mind, a list of necessary test equipment has been made, and preliminary investigations have been made to determine if the necessary equipment can be borrowed in house.

## PROBLEMS

The Post Engineers scheduler removed our request for 400 cycle 3 phase power without informing us of his action.

## WORK PLANNED

- Receive and install the OMTS units
- Test Chamber
- Prepare for Radome Testing

st Information

The following charges have been incurred against the contract during period 1 July, rough 31 July, 1981.

| | Expended | Encumbered |
|---|---|---|
| Personal Services (PS) | $ 1,476.26 | $ -0- |
| Materials and Supplies | 724.14 | 1,072.00 |
| Travel | 54.06 | -0- |
| Overhead (@ 75% of PS) | 1,107.20 | -0- |
| Retirement (@ 11.11% of PS) | 164.01 | -0- |
| TOTAL | $ 3,525.67 | $ 1,072.00 |

ıe breakdown of personal services is as follows:

| | Dollars | Approximate Man Hours |
|---|---|---|
| Principal Research Scientists/Engineers | $ -0- | -0- |
| Senior Research Scientists/Engineers | 1,468.58 | 58.0 |
| Research Scientists II/Engineers II | -0- | -0- |
| Research Scientists I/Engineers I | -0- | -0- |
| Technicians/Draftsmen | -0- | -0- |
| Students | -0- | -0- |
| Secretarial/Clerical/Other | 7.68 | 1.0 |
| TOTAL | $ 1,476.26 | 59.00 |

ıe current financial status of the contract is as follows:

| | Budget As Proposed | Expended | Encumbered | Free Balance |
|---|---|---|---|---|
| Personal Services (PS) | $ 12,498.98 | $ 13,714.01 | $ -0- | $ -1,215.03 |
| Materials and Supplies | 7,805.80 | 1,145.59 | 1,072.00 | 5,588.21 |
| Travel and Shipping | 350.00 | 301.50 | -0- | 48.50 |
| Overhead | 9,124.26 | 10,040.75 | -0- | - 916.49 |
| Retirement | 1,220.96 | 1,372.94 | -0- | - 151.98 |
| FUNDING | $ 31,000.00 | $ 26,574.79 | $ 1,072.00 | $ 3,353.21 |

Based on present full funding, the funding and equivalent man hours are sufficient o complete the task. Approximately 89% of the proposed task has been completed.

A-2926

# Monthly Technical Report No. 8
# and
# Monthly Cost and Performance Report No. 9

Report Period
August 1, through August 31, 1981

Report Prepared
September 21, 1981

## IHAWK Digital Avionics Integration Guidance Concept

T. A. McFADDEN

Contract No. DAAH01-81-D-A003
Delivery Order No. 0013
Project No. A-2926

Prepared for

U. S. Army Missile Command
Attn: DRSMI-IYE/Morris
Redstone Arsenal, Alabama 35898

Prepared by

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

## WORK PERFORMED DURING THIS REPORTING PERIOD

During this reporting period some of the long lead time delivery items have arrived. The new anechoic material was received as was the 10 dB standard gain horn which will be used as an X-band transmitting antenna. The OMTS units from the Marine Corp Depot in Barstow have yet to arrive. An investigation into the status of the OMTS units delivery has uncovered an administrative error resulting in the unusually long delay in shipping these units. An effort was made to correct the error and subsequent delivery of the OMTS units is anticipated.

Material has been collected for performing chamber check-out using the method suggested by Dr. Fahey. Initial measurements have been made using a borrowed standard-gain horn and a spare HAWK antenna as a transmitting antenna. These preliminary results are inconclusive and further testing is planned.

A number of hardware related problems have been discovered in the Radome Positioner Rack. The most serious of these were the failure of a solid state device in the azimuth channel drive motor controller and a catastrophe failure in the EPROM Memory. Both of these problems have been repaired, and the Positioner is now in satisfactory working condition.

## PROBLEMS

None

## WORK PLANNED

- Receive and Install OMTS Units
- Obtain 400 cycle three phase power
- Install the old IHAWK weapons interface in the chamber
- Move radomes to the chamber

Cost Information

The following charges have been incurred against the contract during period August 1, through August 31, 1981.

| | Expended | Encumbered |
|---|---|---|
| Personal Services (PS) | $ -0- | $ -0- |
| Materials and Supplies | 33.11 | -0- |
| Travel | -0- | -0- |
| Overhead (@ 75% of PS) | -0- | -0- |
| Retirement (@ 11.11% of PS) | -0- | -0- |
| TOTAL | $ 33.11 | $ -0- |

The breakdown of personal services is as follows:

| | Dollars | Approximate Man Hours |
|---|---|---|
| Principal Research Scientists/Engineers | $ -0- | -0- |
| Senior Research Scientists/Engineers | -0- | -0- |
| Research Scientists II/Engineers II | -0- | -0- |
| Research Scientists I/Engineers I | -0- | -0- |
| Technicians/Draftsmen | -0- | -0- |
| Students | -0- | -0- |
| Secretarial/Clerical/Other | -0- | -0- |
| TOTAL | $ -0- | -0- |

The current financial status of the contract is as follows:

| | Budget As Proposed | Expended | Encumbered | Free Balance |
|---|---|---|---|---|
| Personal Services (PS) | $ 12,498.98 | $ 13,714.01 | $ -0- | $ -1,215.03 |
| Materials and Supplies | 7,805.80 | 1,178.70 | 1,072.00 | 5,555.10 |
| Travel and Shipping | 350.00 | 301.50 | -0- | 48.50 |
| Overhead | 9,124.26 | 10,040.75 | -0- | - 916.49 |
| Retirement | 1,220.96 | 1,372.94 | -0- | - 151.98 |
| FUNDING | $ 31,000.00 | $ 26,607.90 | $ 1,072.00 | $ 3,320.10 |

Based on present full funding, the funding and equivalent man hours are sufficient to complete the task. Approximately 89% of the proposed task has been completed.

A-2926

FINAL REPORT DAAH01–81–D–A003/0013
PROJECT NO. A–2926

# IHAWK DIGITAL AVIONICS AND INTEGRATED GUIDANCE CONCEPT


**GEORGIA INSTITUTE OF TECHNOLOGY**
**A Unit of the University System of Georgia**
**Engineering Experiment Station**
**Atlanta, Georgia 30332**


1981

November 1981

**Prepared for**

U. S. ARMY MISSILE COMMAND
REDSTONE ARSENAL, ALABAMA 35898

FINAL REPORT
EES/GIT Project No. A-2926

# IHAWK DIGITAL AVIONICS AND INTEGRATED GUIDANCE CONCEPT

## Modification of an Anechoic Chamber to Support Radome Testing and Open-Loop Missile Testing

By

T. A. McFadden
J. L. Dickens
M. H. Thornton

Contract No. DAAH01-81-D-A003
Delivery Order No. 0013

U. S. Army Missile Command
Systems Simulation Directorate
Redstone Arsenal, Alabama 35898

October 1981

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Atlanta, Georgia 30332

| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|---|---|
| 1. REPORT NUMBER | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle)<br>IHAWK DIGITAL AVIONICS AND INTEGRATED GUIDANCE CONCEPT<br>Modification of an Anechoic Chamber to Support Radome Testing and Open Loop Missile Testing | | 5. TYPE OF REPORT & PERIOD COVERED<br>Final Report<br>6. PERFORMING ORG. REPORT NUMBER<br>A-2926- |
| 7. AUTHOR(s)<br>T. A. McFadden, J. L. Dickens, M. H. Thornton | | 8. CONTRACT OR GRANT NUMBER(s)<br>DAAH01-81-D-A003<br>Delivery Order 0013 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Georgia Institute of Technology<br>Engineering Experiment Station<br>Atlanta, Georgia 30332 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>U. S. Army Missile Command<br>Redstone Arsenal, Alabama 35898 | | 12. REPORT DATE<br>October 1981<br>13. NUMBER OF PAGES<br>36 |
| 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)<br>M. M. Hallum, III, DRSMI-RDF | | 15. SECURITY CLASS. (of this report)<br>Unclassified<br>15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |
| 16. DISTRIBUTION STATEMENT (of this Report) | | |
| 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) | | |
| 18. SUPPLEMENTARY NOTES | | |
| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number)<br>Radomes<br>Radome Positioner Measurements System<br>IHAWK Missile Open Loop Test<br>Anechoic Chamber | | |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>This report describes the work done in modifying an existing Anechoic Chamber to be used as a general purpose laboratory facility for performing open-loop IHAWK missile testing and radome measurements. | | |

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE (U)

# PREFACE

This technical report was prepared by the Electromagnetics Laboratory of the Engineering Experiment Station, Georgia Institute of Technology, for the U. S. Army Missile Command, Redstone Arsenal, Alabama. The contract technical manager was E. E. Evers (DRSMI-RDF). Report authors are T. A. McFadden, J. L. Dickens, and M. H. Thornton. The purpose of this report is to document the modification and upgrade of an Anechoic Chamber Facility.

Detailed test data and documentation on the chamber testing will be published in the final report of a related task, "Anechoic Chamber Checkout," Contract DAAH01-81-D-A003, Delivery Order 0029.

Every task specifically identified in the scope of work for task order number 13 has been accomplished with the exception of the inclusion of GFE radome models in the all digital simulator. The models have not been supplied; therefore, it has not been possible to satisfy any all digital simulation activities identified in the task order.

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied of the U. S. Army Missile Command.

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## 1.0 INTRODUCTION

The need has long existed at MICOM for a dedicated Anechoic Chamber Test Facility independent of the Radio Frequency Simulation System (RFSS). Such a chamber would serve as an inexpensive alternative to the RFSS for certain open-loop missile tests and for performing various antenna and radome measurements. Ideally such a chamber would be cost effective to operate and available to the user on short notice, thus eliminating the long-lead scheduling required for the RFSS.

Such a facility has been discovered in the A-wing basement of Building 5400. While in its original state, this chamber did not satisfy all the requirements of the needed Anechoic Chamber; the basic structure itself proved sound enough to warrant investigation. In addition, the A-wing chamber possessed a number of desirable characteristics such as:

- A remote and isolated location, insuring privacy.
- A large antichamber exterior to the Anechoic Chamber with laboratory benches and power supplies suitable for engineering experimentation.
- Close proximity to the power distribution room for the entire building, facilitating the installation of additional power supplies, such as 400 cycle power.
- Convenient access to a freight elevator and an exterior loading ramp.

This report outlines the modifications which were required to permit the A-wing chamber to be used for open-loop HAWK testing, and for radome measurement work.

## 2.0 ANECHOIC CHAMBER DESCRIPTION

### 2.1 General

The A-wing chamber is located on a sublevel beneath the A-wing basement of Building 5400. Figure 1 illustrates the basic layout of the chamber and its exterior engineering laboratory space.

The chamber was originally built in the early seventies to test telemetry antennas on the exterior super structure of missiles. For this reason, the chamber was built with a high ceiling, to accommodate large missile sections. In recent years, however, the chamber has not been used. Fortunately this lack of utilization has not caused the chamber to deteriorate.

Some potential drawbacks exist with the A-wing chamber. As Figure 1 clearly shows, access to the A-wing freight elevator motor room can only be obtained by passing through the chamber's exterior laboratory space. This may pose a security problem should it be necessary to store equipment in the chambers laboratory space. Also the chamber is not RF screened, which would preclude the use of classified RF signatures in the chamber.

### 2.2 Detailed Description

The room which houses the chamber is built of reinforced concrete and sits on a level six feet below the basement of A-wing. The chamber itself sits in the southeast corner of the room and is recessed eleven inches below the floor of the room. Construction of the chamber consists primarily of two inch by four inch wall studs, with five-eighths inch sheet rock hung on the exterior walls.

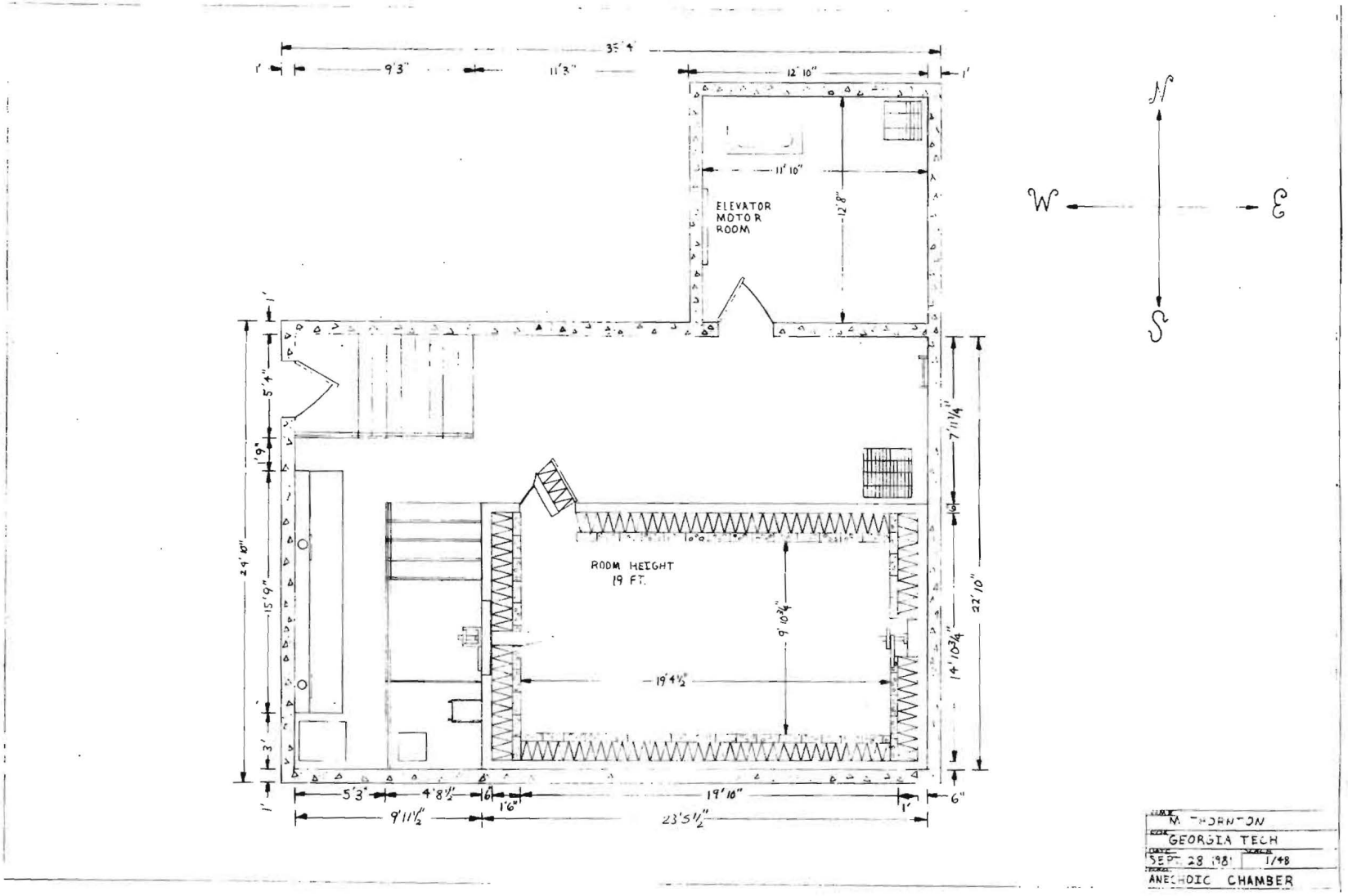



Figure 1. Anechoic Chamber Layout

The two walls of the chamber which jut into the room are essentially hollow nonload bearing walls. These walls extend from the floor of the chamber to within eleven inches of the ceiling of the room. The exterior sheet rock extends from the floor of the exterior room to the ceiling of the chamber. The interior walls of the chamber consist of one-half inch plywood. This plywood covers all four interior walls, plus the ceiling, and is used primarily to support the mounting brackets which hold the anechoic material in place.

Lighting is provided within the chamber by a series of flood lights which are recessed in the anechoic material which covers the ceiling. Alternating current (ac) power is provided within the chamber by a power strip which runs the length of one interior wall, and sits beneath the anechoic material covering the chamber floor. In addition, a series of air conditioning vents recessed in the chamber roof provide cooling.

A laboratory work bench runs the length of the west wall of the exterior room facing the chamber. This bench provides ample storge space for miscellaneous test equipment. Power is provided to this bench through a pair of distribution boxes. These boxes provide 115 volt 60 Hz power, as well as various metered dc supplies and 400 cycle three phase power with both ten amp and fifteen amp service. Compressed air is also supplied to the bench area via two pressure valves.

A set of concrete steps provide access to the room from the basement of A-wing. Storage space is available under these steps. In addition, storage space is available in the elevator motor room. The space between the south wall of the chamber and the exterior room wall may also be used for limited storage.

A sump pump has been provided at the eastern end of the room. This feature was added sometime after the construction of the chamber when it

was discovered that during heavy rains the floor of the room and the chamber floor itself became flooded.

The room outside the chamber has a dropped ceiling, making the height of the room eleven feet. The dropped ceiling hides a series of cable trays which run east to west across the room. These cables supply power to various rooms in Building 5400. A maintenance ladder sits on the eastern wall of the room and provides access to the cable trays.

## 2.3 Anechoic Material Characteristics

Two different types of anechoic material are used in the chamber. The floor of the chamber is covered with Emerson Cummings type CV-CB absorber material. This material is load bearing, capable of supporting 100 pounds per square inch. See Table 1 for a summary of the reflector characteristics of this material.

The walls and ceiling of the chamber are covered with an older type of anechoic material. Documentation on the characteristics and manufacturer of this material was unavailable. Close examination of this material showed its structure to be that of a cardboard, foam laminate. See Figure 2. Each block of this anechoic material consisted of 16 pyramidal shaped structures of approximately eighteen inches in length, bonded to a thin rectangular piece of pressboard backing.

An interesting feature of the anechoic material found on the walls and ceiling of the chamber was that each block of the absorber had a large block of a styrofoam-like material pressed onto the points of the pyramidal absorber structures. It was determined that the styrofoam blocks were used to protect the points of the pyramidal absorber material.

A representative sample of this material was shipped to the Rantek Corporation of Canoga Park, California, for analysis. At Rantek, an NRL arch test was performed on the material. Results of this test are summarized in Table 2.

Table 1

TABLE OF ECCOSORB CV-CB ABSORBER CHARACTERISTICS

| Maximum Reflectivity | Lowest Frequency |
|---|---|
| - 20 db | 400.0 MHz |
| - 30 db | 1.5 GHz |
| - 40 db | 7.0 GHz |

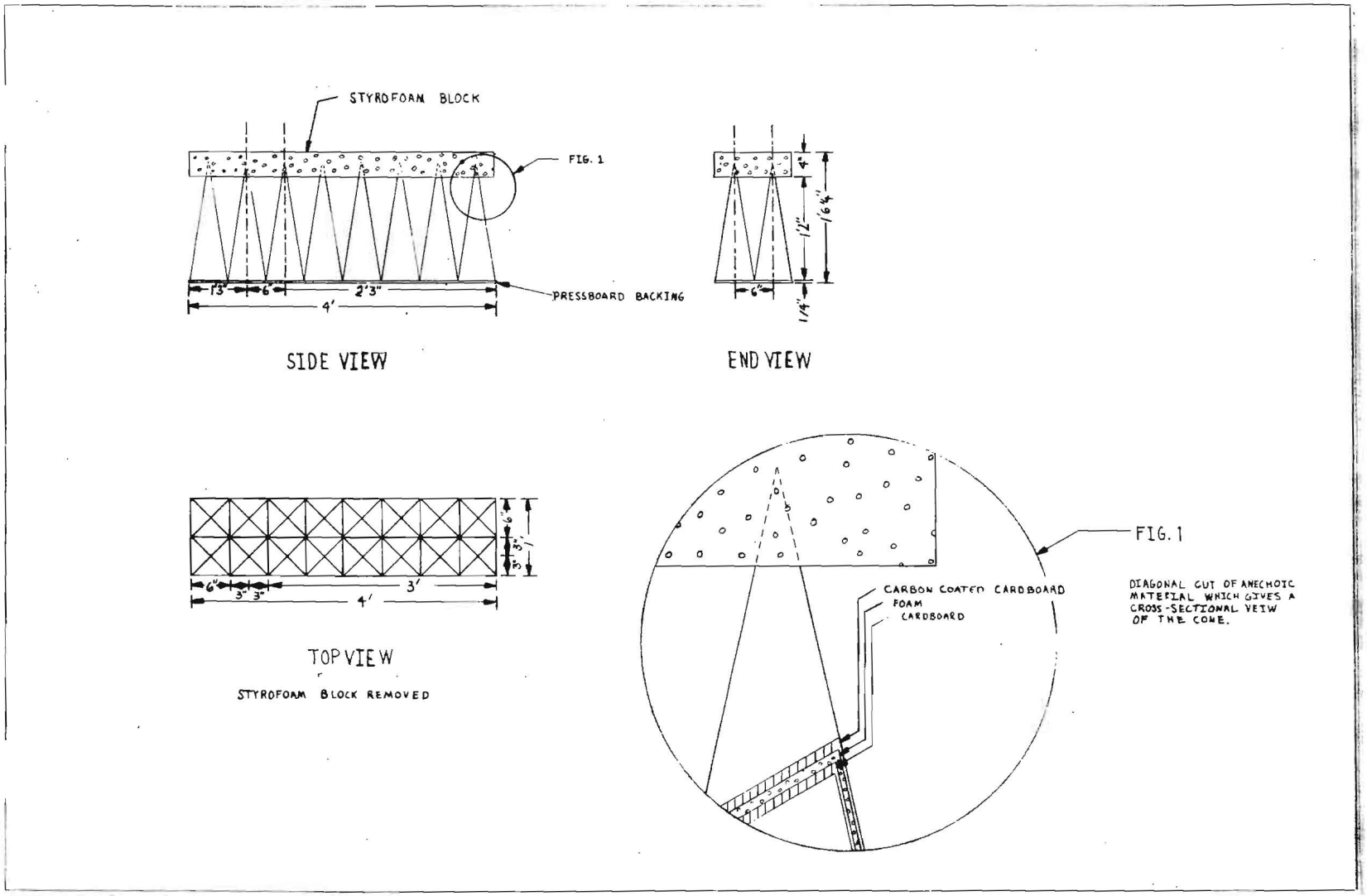



Figure 2. Sidewall Absorber Illustration

Table 2

SIDEWALL ABSORBER CHARACTERISTICS

| Frequency | Incidence Angle From Normal | Horizontal Polarization Reflectivity | Vertical Polarization Reflectivity |
|---|---|---|---|
| 10.0 GHz | 10° | 20.0 db | 29.0 db |
| 10.0 GHz | 20° | 25.5 db | 37.0 db |
| 10.0 GHz | 30° | 29.0 db | 32.6 db |
| 10.0 GHz | 40° | 33.4 db | 40.0 db |
| 10.0 GHz | 45° | 34.0 db | 45.0 db |
| 10.0 GHz | 50° | 33.8 db | 24.5 db |
| 10.2 GHz | 10° | 18.0 db | 26.5 db |
| 10.2 GHz | 20° | 22.0 db | 27.5 db |
| 10.2 GHz | 30° | 25.0 db | 39.0 db |
| 10.2 GHz | 40° | 32.8 db | 43.0 db |
| 10.2 GHz | 45° | 34.5 db | 42.0 db |
| 10.2 GHz | 50° | 37.5 db | 28.5 db |

## 3.0 CHAMBER UPGRADE REQUIREMENTS

The planned principal uses for the A-wing chamber are open-loop missile test and radome measurement tests. Each of these activities has its own diverse set of chamber requirements. In order to efficiently utilize the A-wing chamber for both activities, an audit was made of the needs of both the Radome Measurements Receiver and the Improved HAWK Missile. These needs are outlined in the succeeding sections of this report.

### 3.1 Radome Measurements Receiver

The Radome Measurements Receiver is a system designed and built by the Georgia Tech Engineering Experiment Station for the purpose of investigating the effects of radome induced boresight errors on the guidance of RF Homing Missiles. The system consists of a two axis radome positioner assembly, a microwave receiver system, and a data processing system. See Figure 3.

The positioner gimbal assembly, which supports a missile radome and a missile seeker antenna, was designed to be placed in an aperture in the wall of an Anechoic Chamber. On the opposing chamber wall, an RF transmitting horn is used to provide the RF illumination of the radome under test. Data on the radome being tested is collected in an electronic data processing system housed in a standard nineteen inch rack. A complete description of the Radome Measurements Receiver is contained in Reference 1.

In order to accommodate the Radome Measurements System, a chamber should satisfy the following requirements:

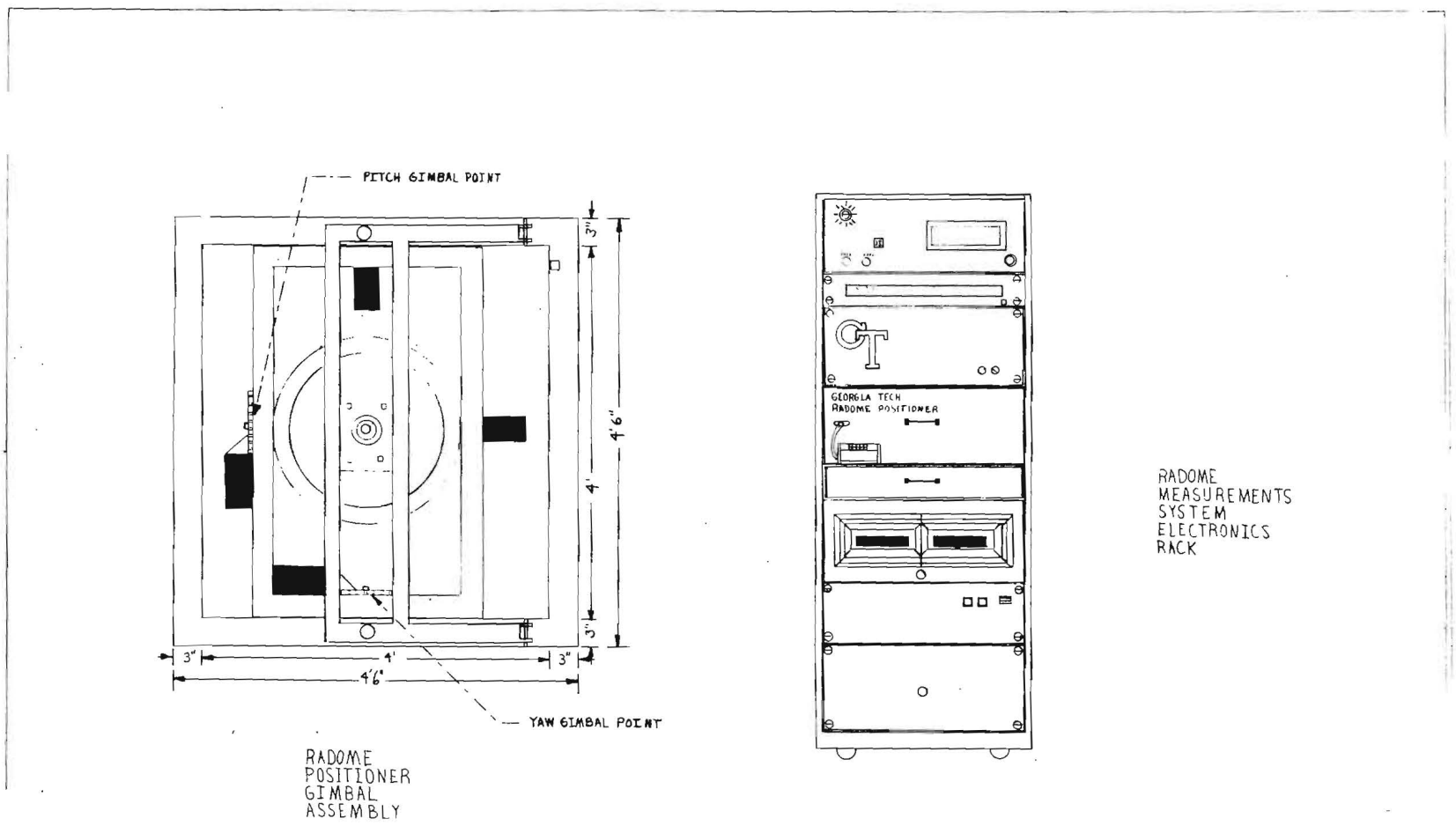



Figure 3. Radome Measurements System

- A candidate chamber should have a wall with an aperture large enough to support the radome positioner. This wall should be strong enough to prevent any flexing or motion of the radome positioner when the gimbals are moved during the execution of a radome test.

- A candidate chamber should be large enough to satisfy the far field requirements of the seeker antenna and the transmitting antenna.

- A candidate chamber should have an acceptable quiet zone where spurious sidewall reflections are attenuated to level compatible with the desired measurement accuracy.

- A candidate chamber should allow free access to the Radome Measurements Receiver for data analysis.

At the outset of this project, it was not certain if the A-wing chamber satisfied the above requirements. First of all, the chamber did not possess a wall with an aperture large enough to support the Radome Positioner Assembly. Also, the characteristics of the quiet zone for the chamber were unknown. The decision was made, however, to modify the chamber in any way necessary to allow its use with the Radome Measurements System. This decision was based on the belief, fostered by discussions with previous chamber users, that the chambers quiet zone would prove adequate for the planned testing.

## 3.2 IHAWK Open-Loop Missile Test

When open-loop tests are performed on the IHAWK Missile, what is typically done is to remove from the missile the guidance and control electronics along with the seeker head and its associated gimbals and hydraulic drive actuators. Once removed from the missile, the guidance and

control package is mounted on a support stand, and the seeker head is positioned in an aperture in the wall of an Anechoic Chamber. A transmitting antenna is placed on the opposing wall of the chamber to provide an RF source for simulating targets. When the missile guidance and control package is cabled to a specifically designed weapons interface and hydraulic power is applied to the seeker drive actuators, open-loop tests can be performed.

Assuming that a weapons interface is available, and that a source of hydraulics is provided, there are some specific requirements which an Anechoic Chamber must meet in order to be used for open-loop I-HAWK Missile testing. These requirements are:

- A candidate chamber should have a wall with an aperture large enough to accommodate the missile seeker. This aperture should be positioned well within the quiet zone of the chamber.

- A support platform should be provided on the exterior wall of the chamber at a height which would allow the missile guidance and control package and the seeker to be positioned in the center of the wall aperture.

- A candidate chamber should be large enough to satisfy the far field requirements of the missile seeker antenna and the transmitting antenna.

- A candidate chamber should have an acceptable quiet zone where spurious sidewall reflections are attenuated to a level compatible with the desired measurement accuracy.

As was the case with the requirements for the Radome Measurements Receiver, it was initially uncertain if the A-wing chamber met all the

requirements for supporting open-loop missile testing. However, enough commonality existed between the two sets of requirements that it was felt if the chamber could be modified to satisfy the needs of the Radome Measurements System, then it could be made to accommodate open-loop missile testing.

## 4.0 CHAMBER MODIFICATIONS

### 4.1 Aperture

The first major requirement of the A-wing chamber was for an aperture. Given the dimensions and layout of the chamber, the west wall was chosen as the wall into which an aperture should be cut. This wall provided the necessary access space outside the chamber for placement of a support platform and the auxiliary equipment required by the radome measurements system and missile testing. Also this wall permitted the long interior dimension of the chamber to provide the spacing required for far field placement of the antennas.

The dimensions of the aperture were driven by the requirements of the radome positioner which requires a larger aperture than that required for the missile. The Radome Positioner Gimbal Assembly was designed to fit in an aperture which is four feet square. Therefore, an aperture of this size was cut into the west wall of the chamber at the approximate midpoint of the wall.

The opening of this aperture revealed the interior structure of the chamber wall. It became readily apparent that the chamber wall was not strong enough to provide the support required for the Radome Positioner without some additional modifications. For this reason, an aluminum support stand was designed to assist in supporting the Radome Positioner. See Figure 4.

The Aluminum I-Beam support sits in the void between the interior and exterior wall of the chamber between a pair of two inch by four inch wall studs. The I-Beam Assembly extends from the interior chamber floor to just above the aperture opening. The lower portions of the two vertical I-Beam stands are anchored to the reinforced concrete which forms the floor of the room exterior to the chamber.

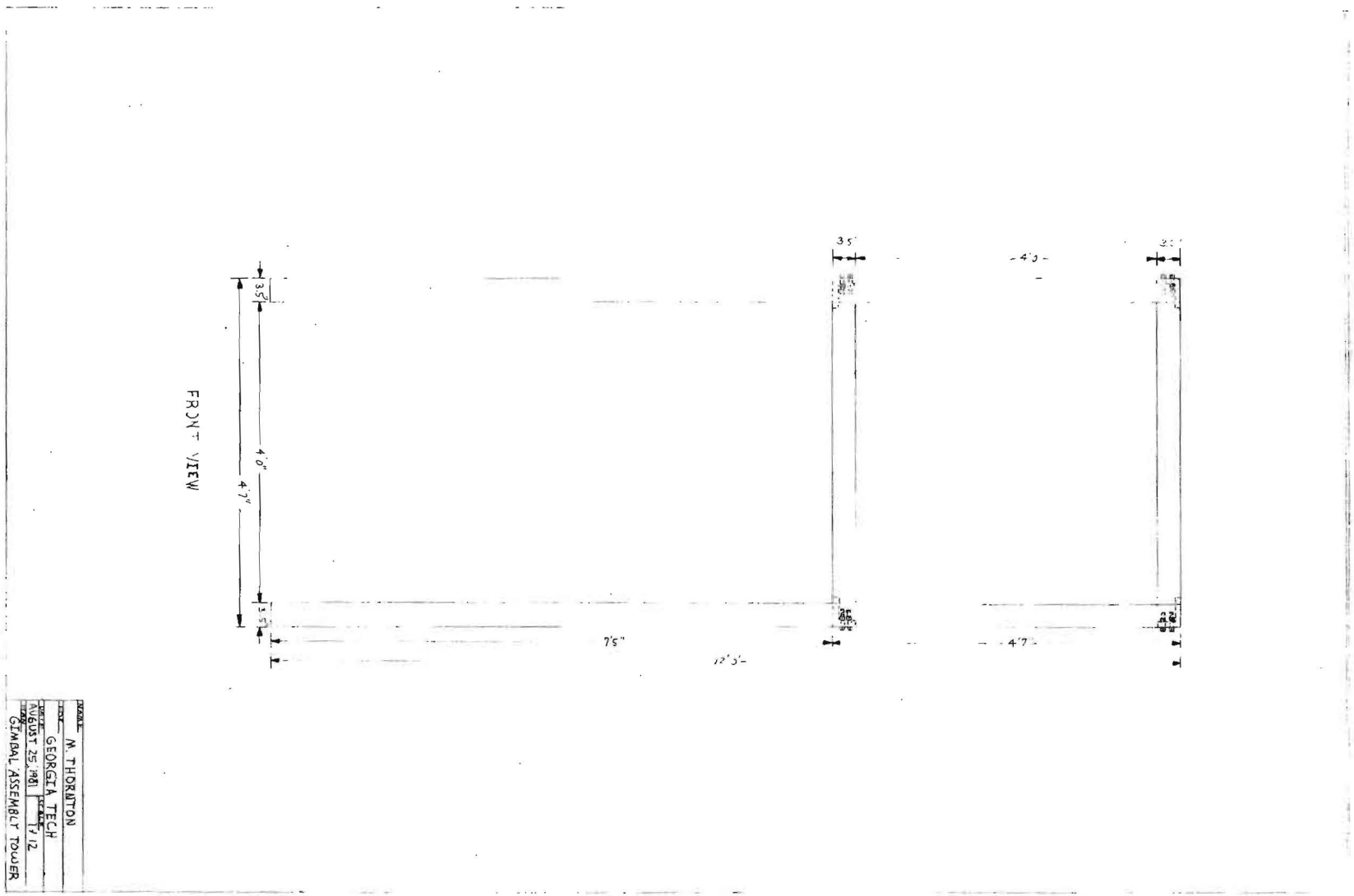



Figure 4. Aluminum Support Stand

The vertical stands of the I-Beam assembly are joined by two cross members. One crossmember connects the top of the stands, and one connects the stands at a level four feet from the top. Thus the crossmembers effectively form an aluminum support frame into which the Radome Positioner gimbal assembly can be placed.

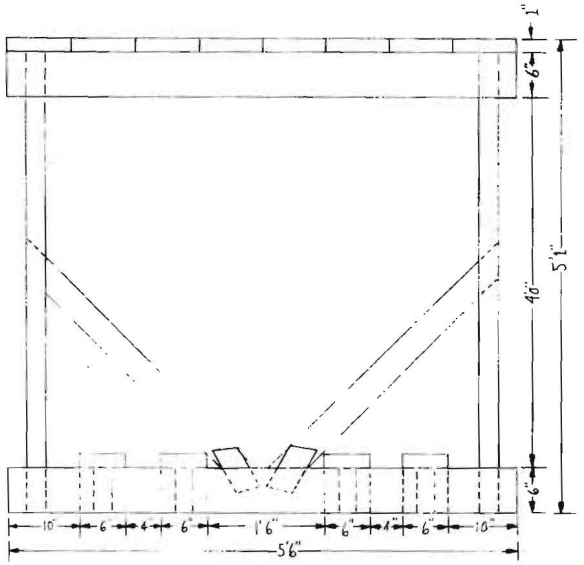
In the interior of the chamber, the anechoic material covering the aperture, and the space immediately surrounding the aperture was removed. It was necessary to remove the surrounding material to allow the unimpeded travel of a radome mounted on the Radome Positioner.

## 4.2 Support Platform

After opening up the wall aperture, it next became necessary to provide a Support Platform. This platform would allow access to the aperture for mounting the Radome Positioner, and support for the IHAWK missile and weapons interface.

It was decided to construct the platform out of wood so that it might be easily disassembled. Also, to provide sufficient space on the platform for all the necessary equipment and support personnel required for missile testing, it was necessary for the platform to span the length of the west wall of the chamber. Since the aperture was centered vertically on the chamber wall, the platform had to be approximately five feet tall. This necessitated the building of steps from the floor of the room to the top of the platform. The space under the platform provides a convenient storage area. (See Figures 5 through 9 for detailed drawings of the platform.)

In order to provide access to the laboratory work bench, the platform was limited to a width of four and three-fourths feet. This allows a clearance of two and one-half feet between the platform and the work bench.




FRONT VIEW

| MATERIALS | | |
|---|---|---|
| QUAN | DESCRIPTION | SIZE |
| 15 | LUMBER | 2"X6"X10" |
| 4 | LUMBER | 1"X8"X10" |
| 1 | PLYWOOD | 3/4"X4'X8' |

M THORNTON
GEORGIA TECH
MARCH 18 1981 1/12
STAND A

Figure 5. Platform Front View

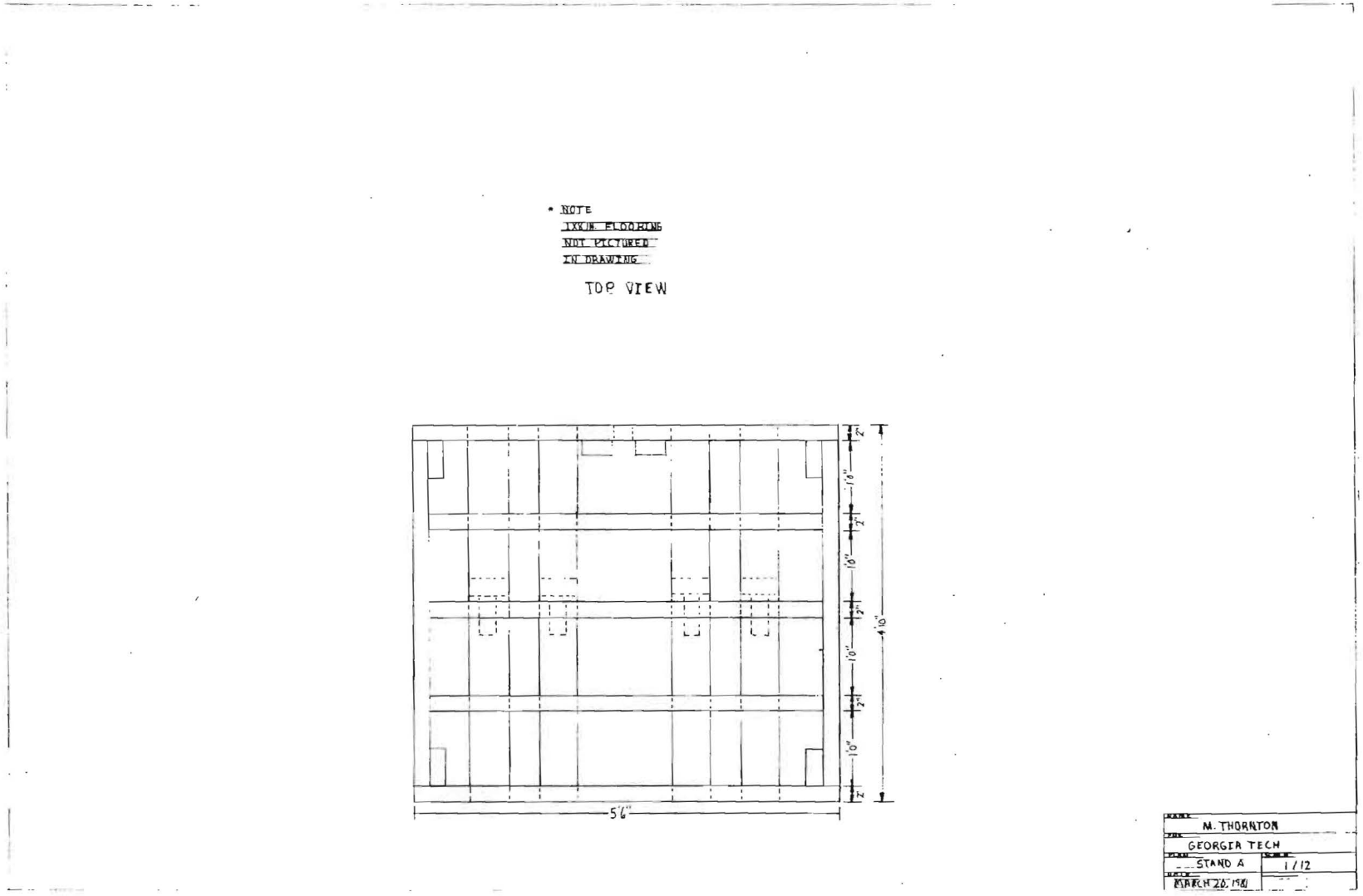



Figure 6. Platform Top View

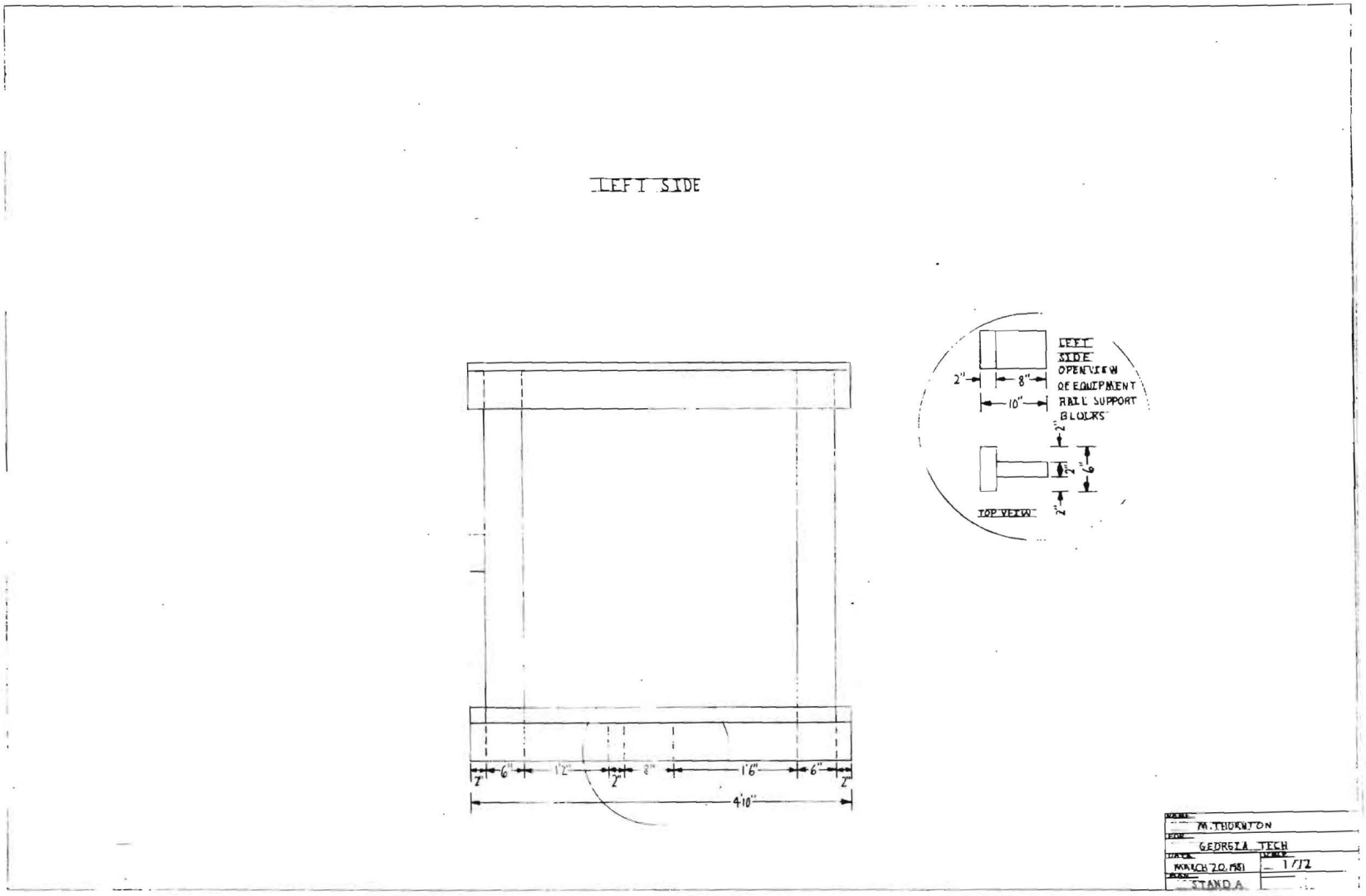



Figure 7. Platform Left Side View

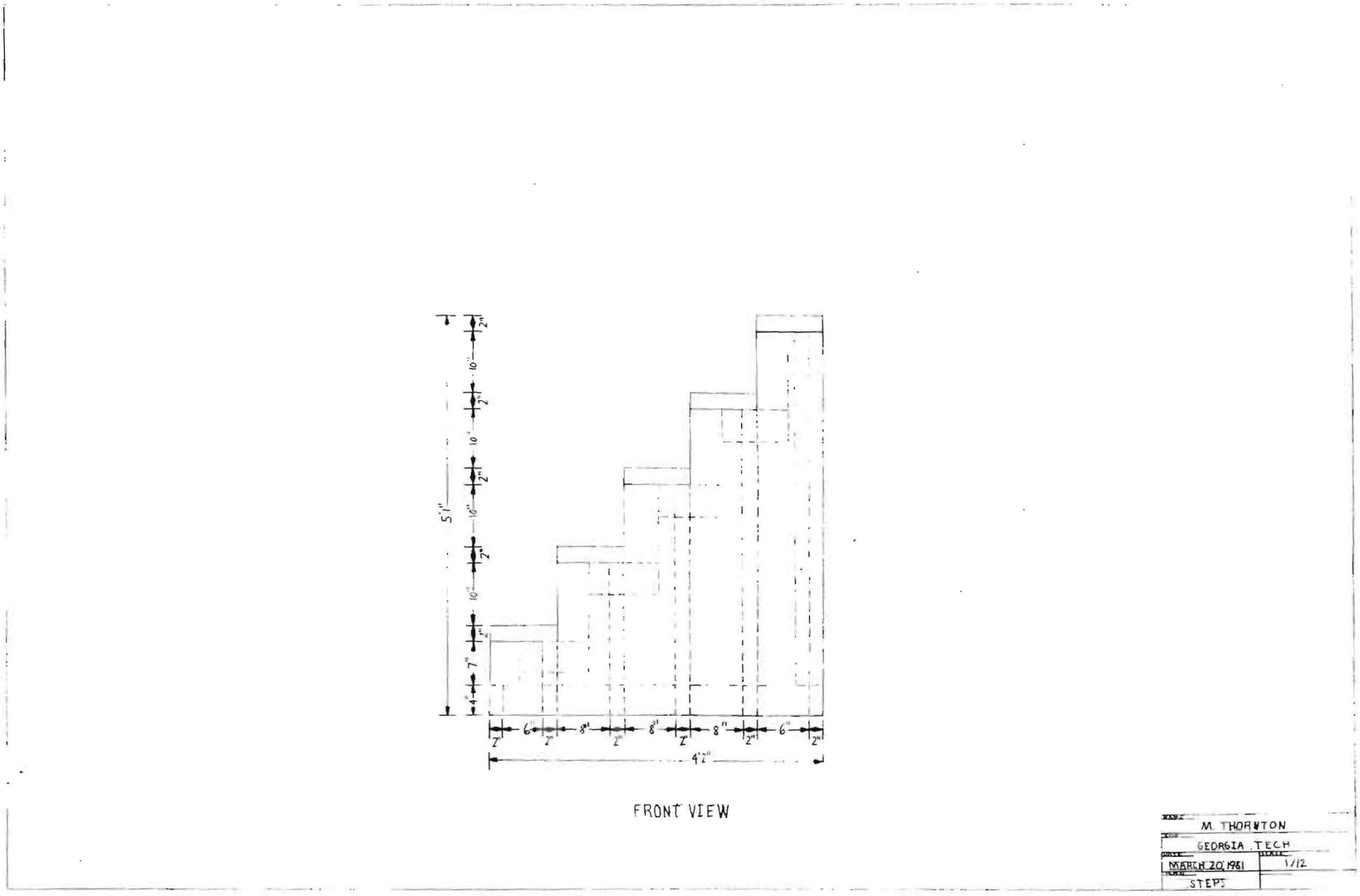



Figure 8. Platform Steps Front View

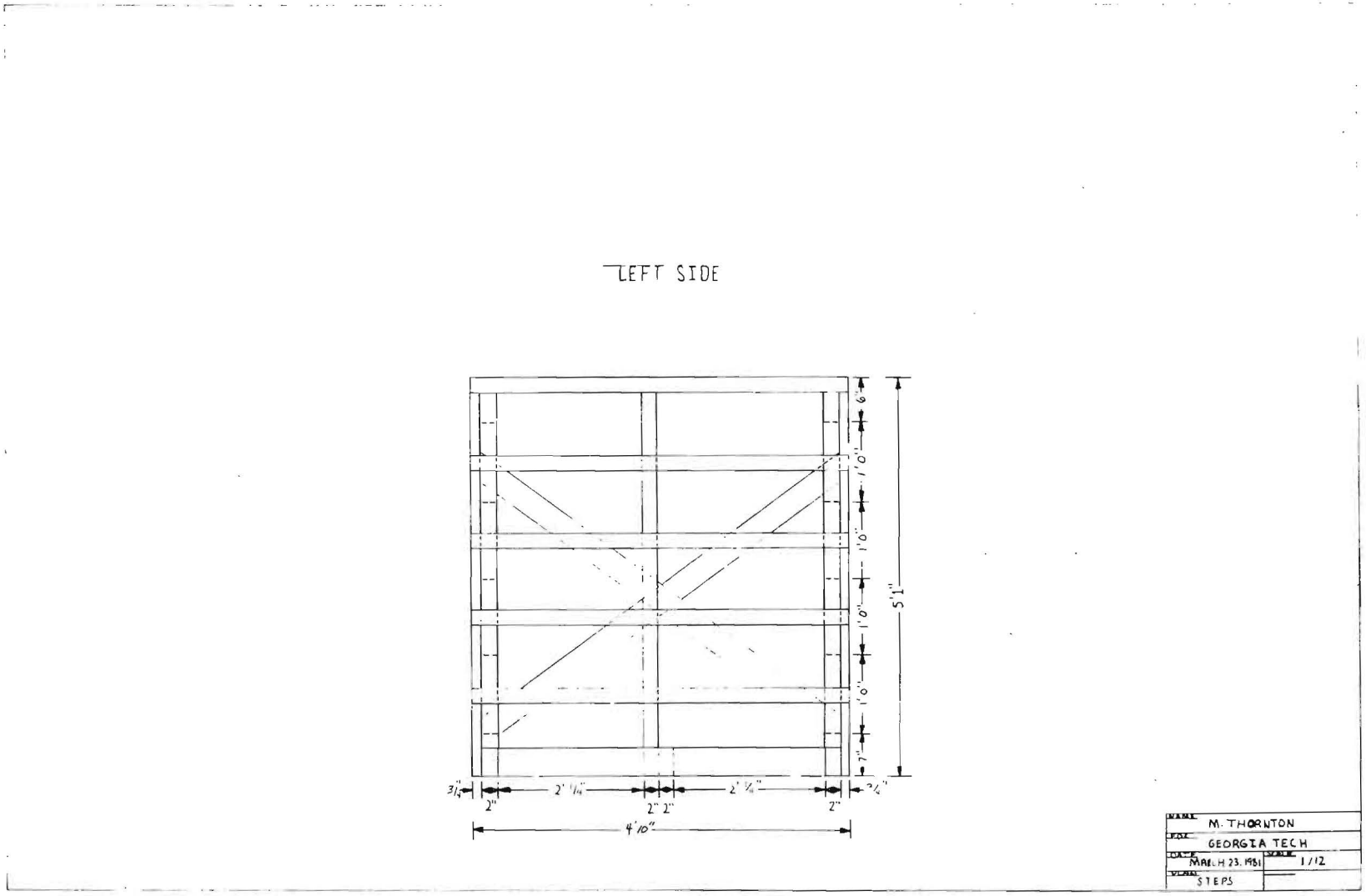



Figure 9. Platform Steps Left Side View

## 4.3 Antenna Tower

Both the Radome Measurements Receiver and missile testing require a transmitting antenna on the interior wall of the chamber facing the aperture. However, to provide greatest flexibility for missile testing, the transmitting antenna should be movable to various locations on the interior wall. Also, it is desirable for missile testing to have the capability of mounting more than one transmitting horn on the interior wall to allow simulation of multiple targets.

Thus the design of an antenna mounting apparatus was driven by the requirements of missile testing since these requirements were more severe than those of the Radome Measurements Receiver. The design chosen (See Figure 10) was that of a tower having three degrees of freedom in its vertical mounting plane. In order to accommodate the antenna tower, it was necessary to remove several blocks of ancehoic material from the wall of the chamber.

The tower itself was constructed of wood and consists of a fixed lattice support frame approximately nine feet in height to which was attached a large wooden mounting disc and a support arm. The disc and support arm are movable and are secured to the support frame by a set of large wing nuts (See Figure 11).

For supporting radome measurements testing and single target missile tests, a transmitting horn may be mounted in the center of the wooden disc. The positioning of the antenna, once mounted, may be adjusted by loosening the wing nuts and sliding the disc and support arm assembly to the desired position vertically or horizontally. Once in the desired location, the wing nuts may be tightened again to secure the antenna in place. Additional flexibility may be obtained by loosening the bolt which attaches the wooden disc, and rotating the disc to the desired orientation. This

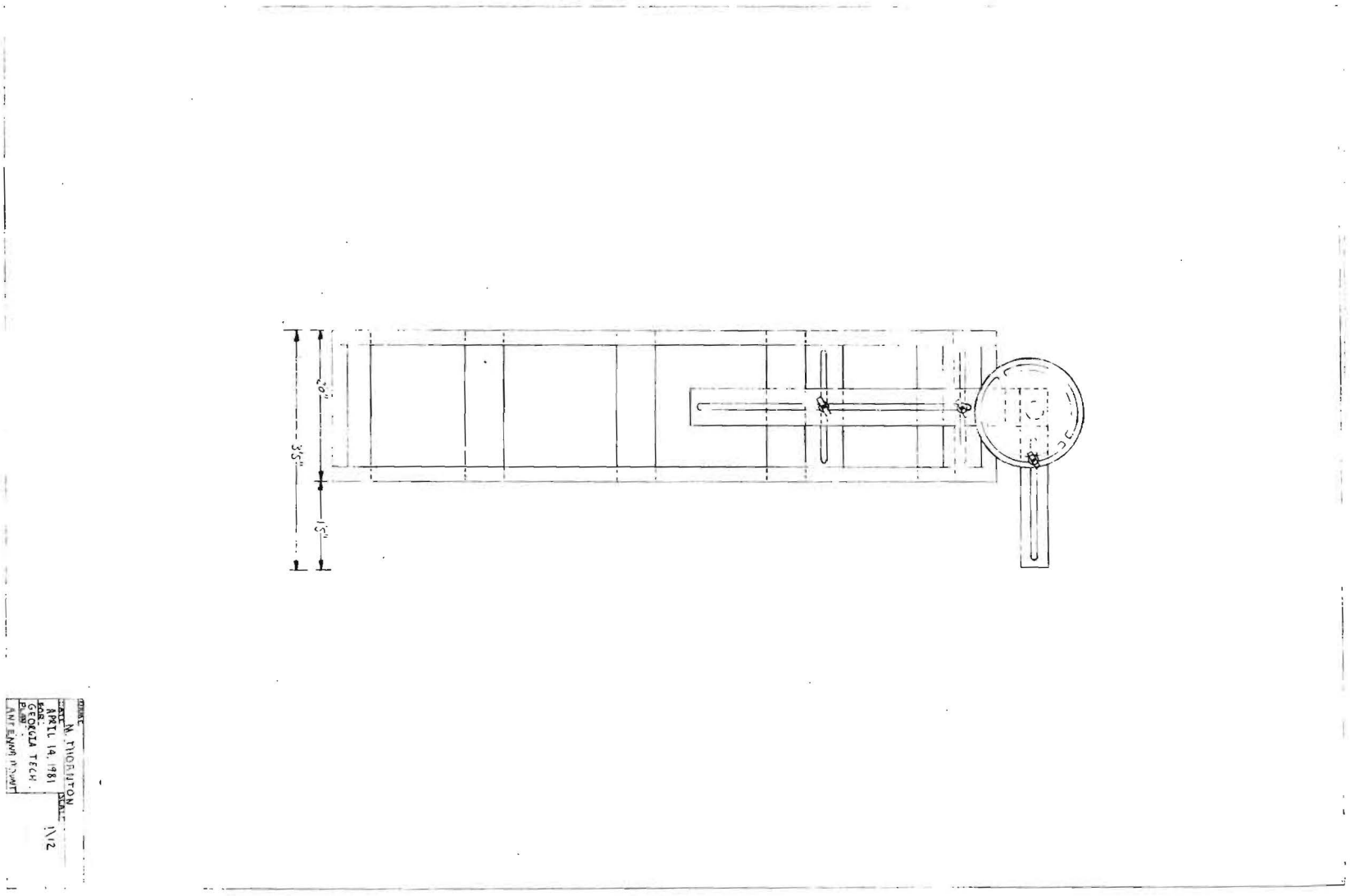



Figure 10. Antenna Tower Front View

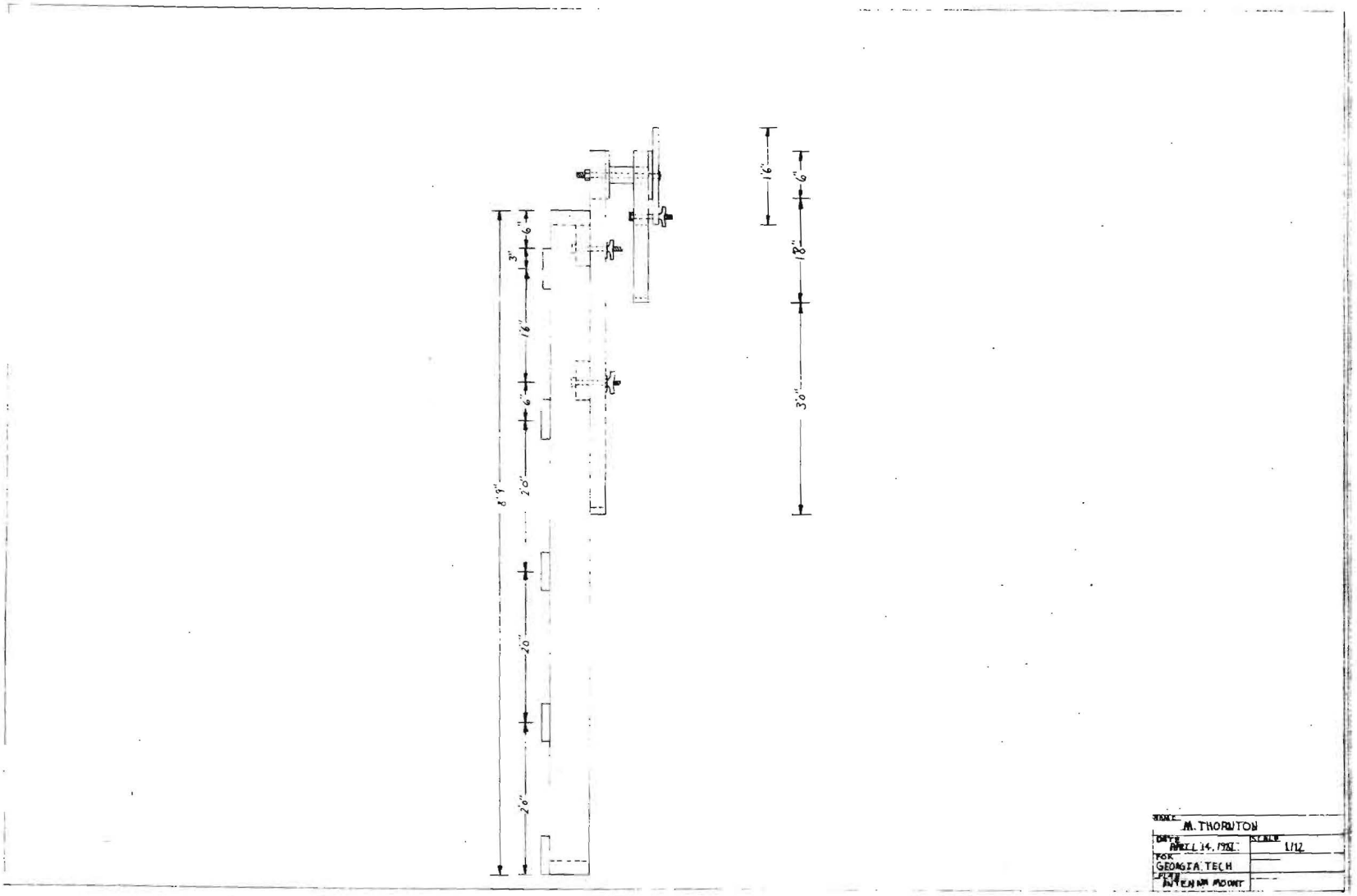



Figure 11. Antenna Tower Side View

feature allows the user to use a single fed horn, and to rotate the horn to achieve either horizontal or vertical polarization.

When supporting multiple target missile testing, a pair of transmitting antennas may be mounted on the tower. One horn may be mounted on the center of the disc, and a second antenna may be mounted on the swing arm. The spacing of the antennas may be adjusted by positioning the second antenna on the swing arm at the desired spacing. The orientation of the second antenna to the first can be accomplished by loosening the swing arm wing nut and rotating the swing arm until the desired orientation is achieved. Using the above procedure, it is possible to simulate two targets having any desired orientation with respect to each other in the same vertical plane, and any angular separation between two and four degrees.

In operation, RF may be cabled into the chamber and the cabling may run up the sides of the antenna tower for attachment to the transmitting horns. Space exists on the tower for mounting a switching box if it is desired to switch RF between the horns.

## 4.4 Auxiliary Modifications

### 4.4.1 OMTS Unit

Once the physical modifications to the chamber were accomplished, it became necessary to address the additional requirements necessary for missile test. Specifically, a source of RF and hydraulics had to be provided. Fortunately, a source of RF and hydraulics was discovered in Government surplus basic HAWK OMTS units. These units, warehoused in the Marine Corps Supply depot in Barstow, California, are self contained missile test stations containing both the required RF sources for front and rear lock, and a hydraulic pump required for powering the missile seeker head.

Space was provided in the chambers exterior laboratory area for housing an OMTS unit under the support platform. This location is desirable as it permits the OMTS unit to be positioned as close as possible to the missile under test. Since the hydraulic hoses, which normally accompany the OMTS unit are short, it is important to minimize the spacing between the missile and the unit.

### 4.4.2 Power Supply

Power is available in the chamber laboratory space for any auxiliary equipment required to support radome testing and missile test with the exception of the OMTS unit. Since this unit was designed as a piece of military field support gear, it requires 400 cycle power. Four hundred cycle power is available in the chamber facility but it is three-phase power at 115 volts, whereas the OMTS unit requires 400 cycle three-phase power at 416 volts. To correct his, a bank of transformers were installed to provide the necessary power.

### 4.4.3 Test Bench Modification

In an effort to avoid cluttering the support platform with auxiliary test equipment, it was decided to not position the Radome Measurements Receiver electronics rack on the platform. This left the space between the platform and the laboratory bench as the most likely spot for positioning the electronics rack. Initially, the rack was placed there but it soon became apparent that this was an inefficient utilization of the available space. Thus the decision was made to shorten the laboratory bench to allow the radome measurements electronic rack to be positioned in the southwest corner of the room. This left the entire space between the platform and the bench free from obstruction.

The cabling which was designed for interfacing the electronics rack to the Radome Positioner gimbal assembly was too short to use with the rack in its location in the corner of the room. It was therefore necessary to lengthen these cables. This was accomplished by mounting a cable junction box on the wall of the chamber and supplying additional cabling from the junction box to the Radome Positioner gimbal assembly.

## 5.0 MODIFIED CHAMBER OVERVIEW

The modifications described above have succeeded in transforming an unused Anechoic Chamber into an efficient research facility for performing radome measurements and open-loop IHAWK missile testing.

An aperture has been provided for both activities, a flexible antenna tower has been built to support both test programs, a support platform has been built and the auxiliary test equipment has been conveniently positioned to create a highly efficient laboratory work area. The only activity which remains is to test the quiet zone of the chamber.

The far field requirements can be used to determine the dimensions of the transmitting antenna for the chamber. Since the IHAWK seeker is used for both missile testing and radome measurements work as currently planned, the difference between internal chamber length and the far field of the I-HAWK seeker determine the specification for the transmitting horn.

Using the far field rule of thumb (Ref. 2):

$$\text{Far Field} = \frac{2D^2}{\lambda} \tag{5.1}$$

D = Antenna Aperture Dimension in meters

$\lambda$ = Wavelength in meters.

The IHAWK seeker has a far field of approximately 17 feet. This leaves about three feet to satisfy the far field for the transmitting horn. Again using the far field rule of thumb, the transmitting horn may have an antenna aperture of slightly over four inches.

The quiet zone characteristics of the chamber will be determined during follow-on testing. This testing and its results will be reported in the final report of Contract DAAH01-81-D-A003, Delivery Order 0029.

## REFERENCES


1. Bird, R. W., Kozakoff, D. J., and Schuchardt, J. M., "Design and Fabrication of a Radome Measurements Receiver," EES Final Report on Project A-2314, prepared for U. S. Army Missile Research and Development Command, Redstone Arsenal, Alabama, Contract No. DAAK40-78-D-0008, Work Order 0008, October 1979.

2. Kozakoff, D. J., "Design Considerations for Anechoic Chambers," Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia 30332.